



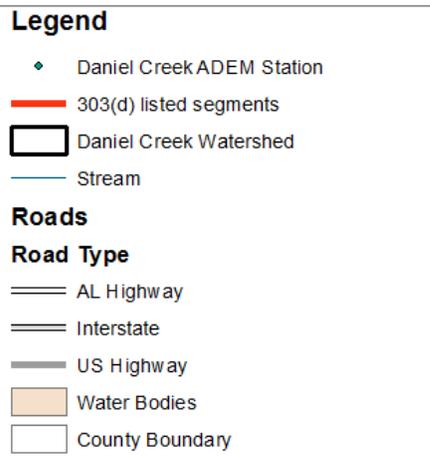
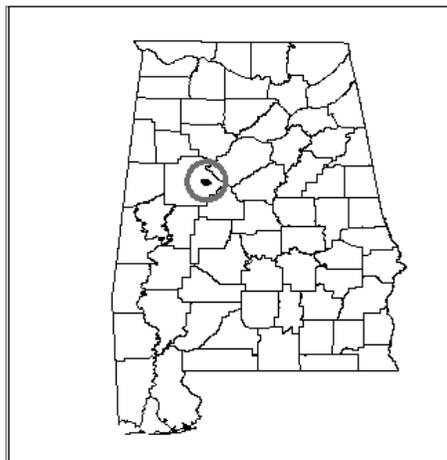
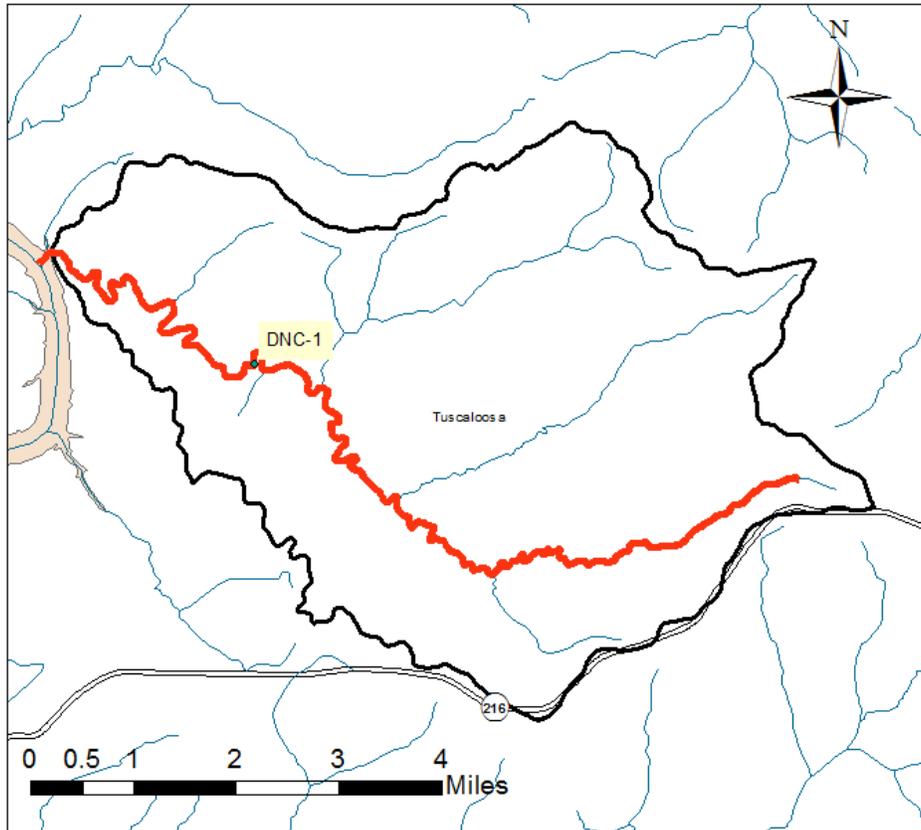
**Draft
Delisting Decision
for
Daniel Creek**

Waterbody ID AL03160112-0305-110

Metals (Cr, Pb)

Alabama Department of Environmental Management
Water Quality Branch
Water Division
February 2014

Daniel Creek Watershed Map in the Black Warrior River Basin



<i>Table of Contents</i>	<i>Page</i>
1. Executive Summary	4
2. Basis for §303(d) Listing	5
2.1 Introduction	5
3. Technical Basis for Delisting Decision	5
3.1 Water Quality Target Identification	5
3.2 Source Assessment	6
3.3 Land Use Assessment	8
3.4 Data Availability and Analysis	10
4. Conclusions	12
5. Public Participation	13
6. Appendices	
6.1 References	14
6.2 Water Quality Data	15
6.3 Equations for calculating specific metals criteria	17
6.4 Daniel Creek Photos	20

List of Tables and Figures

Table 3.1	Sources for the Daniel Creek Watershed	6
Table 3.2	Land Use Areas for the Daniel Creek Watershed	9
Table 3.3	Summary of Metals Analysis for Daniel Creek	11
Table 3.4	Daniel Creek Sampling Stations	11
Table 3.5	Summary of 2012 Daniel Creek Metals (Cr, Pb) Results	11
Table 3.6	Summary of 2007 Daniel Creek Metals (Cr, Pb) Results	11
Figure 3.1	Source Map for the Daniel Creek Watershed	7
Figure 3.2	Land Use Map for the Daniel Creek Watershed	8
Figure 3.3	Land Use Graph of the Daniel Creek Watershed	9
Figure 3.4	Map of Sampling Locations for Daniel Creek	12

1.0 Executive Summary

Daniel Creek, located in Tuscaloosa County, is a part of the Black Warrior River Basin. Daniel Creek originates in central Tuscaloosa County, and runs northwest ten miles before draining into the Black Warrior River. Daniel Creek has a use classification of Fish & Wildlife (F&W).

In 2006, Daniel Creek was originally listed for metals on the State of Alabama's 303(d) list. The 10.45 mile length of the impaired segment was from its source to the Black Warrior River. The original listing was reportedly based on data collected from 1999 by the Alabama Department of Environmental Management (ADEM). The data was collected from DNC-1. Daniel Creek has subsequently been listed on Alabama's 2008, 2010 and 2012 §303(d) lists of impaired waterbodies.

Over the last five years, additional data has been acquired for Daniel Creek to assess its ability to meet applicable water quality standards. The data indicates that Daniel Creek, from Black Warrior River to its source, now fully supports its use classification with respect to Chromium (Cr) and Lead (Pb).

The following report addresses the results of the delisting analysis of Daniel Creek for chromium and lead. Based on an assessment of all available data, ADEM has determined that a water quality impairment due to metals (Cr, Pb) does not exist. Therefore, ADEM will not develop a TMDL due to "more recent or accurate data" which is just cause for delisting a waterbody according to Title 40 of the Code of Federal Regulations (CFR), Part 130.7(b)(6)(iv).

2.0 Basis for §303(d) Listing

2.1 Introduction

Section 303(d) of the Clean Water Act (CWA) as amended by the Water Quality Act of 1987 and EPA's Water Quality Planning and Management Regulations [(Title 40 of the Code of Federal Regulations (CFR), Part 130)] requires states to identify waterbodies which are not meeting water quality standards applicable to their designated use classifications. The identified waters are prioritized based on severity of pollution with respect to designated use classifications. TMDLs for all pollutants causing violation of applicable water quality standards are established for each identified water. Such loads are established at levels necessary to implement the applicable water quality standards with seasonal variations and margins of safety. The TMDL process establishes the allowable loading of pollutants, or other quantifiable parameters for a waterbody, based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water-quality based controls to reduce pollution from both point and non-point sources and restore and maintain the quality of their water resources (USEPA, 1991).

The current §303(d) list states that Daniel Creek is impaired for a length of 10.42 miles from Black Warrior River to its source. The original listing was reportedly based on data collected from 1999 by ADEM. Habitat quality was assessed as excellent for Daniel Creek. Three EPT families were collected, indicating the macroinvertebrate community to be in poor condition. Intensive water quality data were collected from Daniel Creek at DNC-1 from May through September of 1999. Mean conductivity was 1,922 μ mhos at 25°C, approximately 19 times greater than values measured at least-impaired ecoregional reference sites. Chromium, iron, and manganese were periodically elevated. Daniel Creek has subsequently been listed on the 2008, 2010 and 2012 §303(d) lists of impaired waterbodies. Daniel Creek has a use classification of Fish & Wildlife (F&W).

3.0 Technical Basis for Delisting Decision

3.1 Water Quality Target Identification

According to ADEM's Water Quality Criteria (Administrative Code 335-6-10-.07), both acute and chronic aquatic life criteria and human health (consumption of fish only) criteria are applicable for waterbodies classified as Fish and Wildlife.

Acute and chronic aquatic life criteria for most metals are hardness dependent. Hardness values must be entered into equations that are specific to each metal. These equations are provided in Appendix 6.3. Metals criteria for Daniel Creek were calculated using individual hardness values from each sampling event at each sampling station. Table 3.3 of Section 3.4 depicts specific water quality targets for each metal of concern at each station sampled.

3.2 Source Assessment

3.2.1 Point Sources in the Daniel Creek Watershed

Continuous Point Sources

Currently there are no active NPDES Permits within the listed portion of the Daniel Creek watershed.

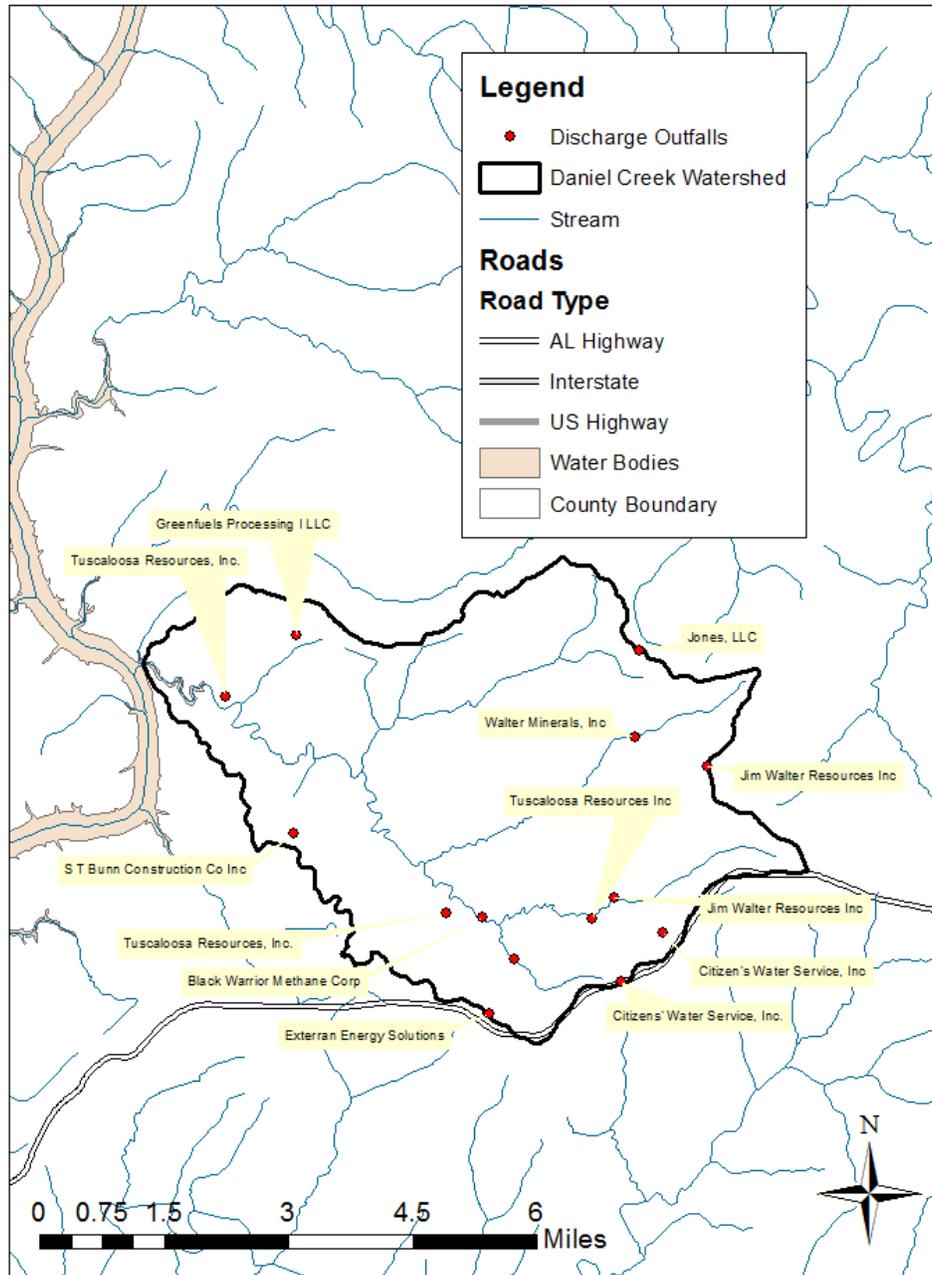
Non-Continuous Point Sources

Daniel Creek has multiple NPDES regulated stormwater and mining permits. Figure 3-1 and Table 3-1 display the source for the Daniel Creek watershed. There are no CAFOs located in the Daniel Creek watershed. Currently none of the Daniel Creek watershed qualifies as a Municipal Separate Stormwater Sewer System (MS4) area.

Table 3-1. Sources for the Daniel Creek Watershed

Name	Permit Number	Type
Tuscaloosa Resources Inc.	AL0074152	Mining
Greenfuels Processing I LLC	AL0022861	Mining
ST Bunn Construction Co Inc.	ALR320310	Mining General Permit
Tuscaloosa Resources Inc.	AL0075043	Mining
Black Warrior Methane Corp	AL0054062	Mining
Abston Construction Company Inc.	AL0055735	Mining
Exterran Enegy Solutions	ALG120700	Industrial General
Tuscaloosa Resources Inc.	AL0070777	Mining
Jim Walter Resources Inc.	AL0029475	Industrial General
Citizens' Water Service, Inc.	ALR109037	Industrial General
Citizens' Water Service, Inc.	ALR109732	Industrial General
Walter Minerals, Inc.	AL0080578	Mining
Jones, LLC	ALR109959	Industrial General
Jim Walter Resources Inc.	ALG140042	Industrial General

Figure 3-1. Source Map for the Daniel Creek Watershed



3.2.2 Nonpoint Sources in the Daniel Creek Watershed

From review of the data collected on Daniel Creek it is believed that nonpoint sources are not causing or contributing to any Chromium or Lead issues in Daniel Creek.

3.3 Land Use Assessment

Land use for the Daniel Creek watershed was determined using ArcMap with land use datasets derived from the 2006 National Land Cover Dataset (NLCD). Figure 3-2 and Table 3-2 display the land use areas for the Daniel Creek watershed. Figure 3-3 is a graph depicting the primary land uses in the Daniel Creek watershed.

The majority of the Daniel Creek watershed is Forest and Developed which accounts for 85.07% and 13.92 % respectively. Developed land includes, mining (barren land), commercial and residential land uses.

Figure 3-2. Land Use Map for the Daniel Creek Watershed

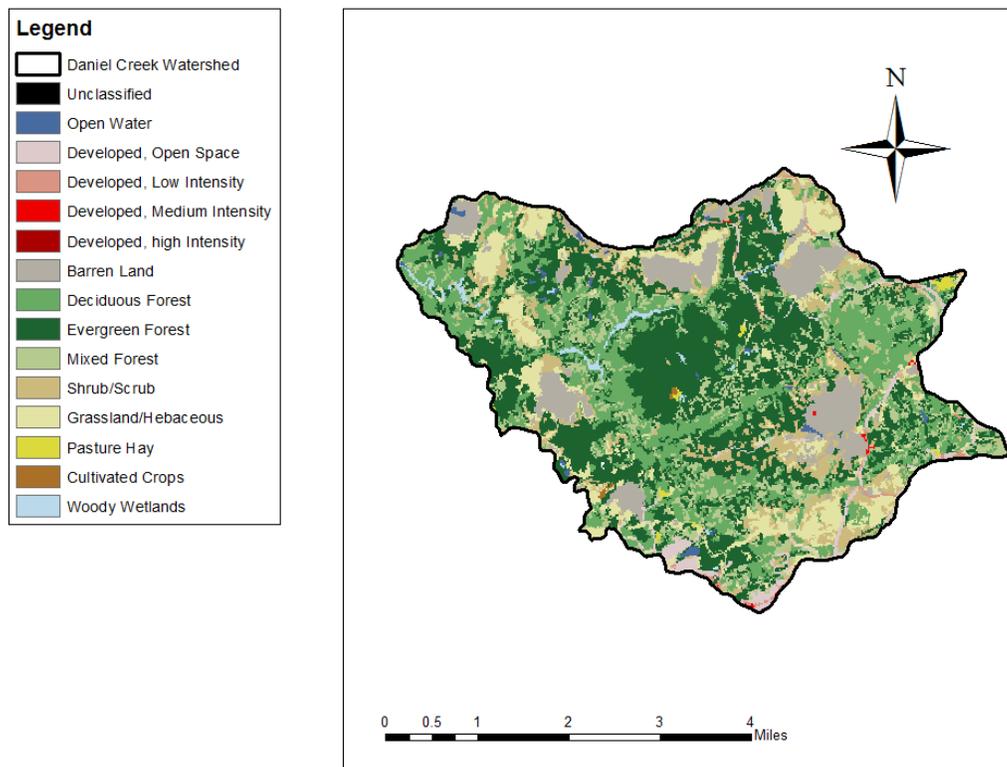
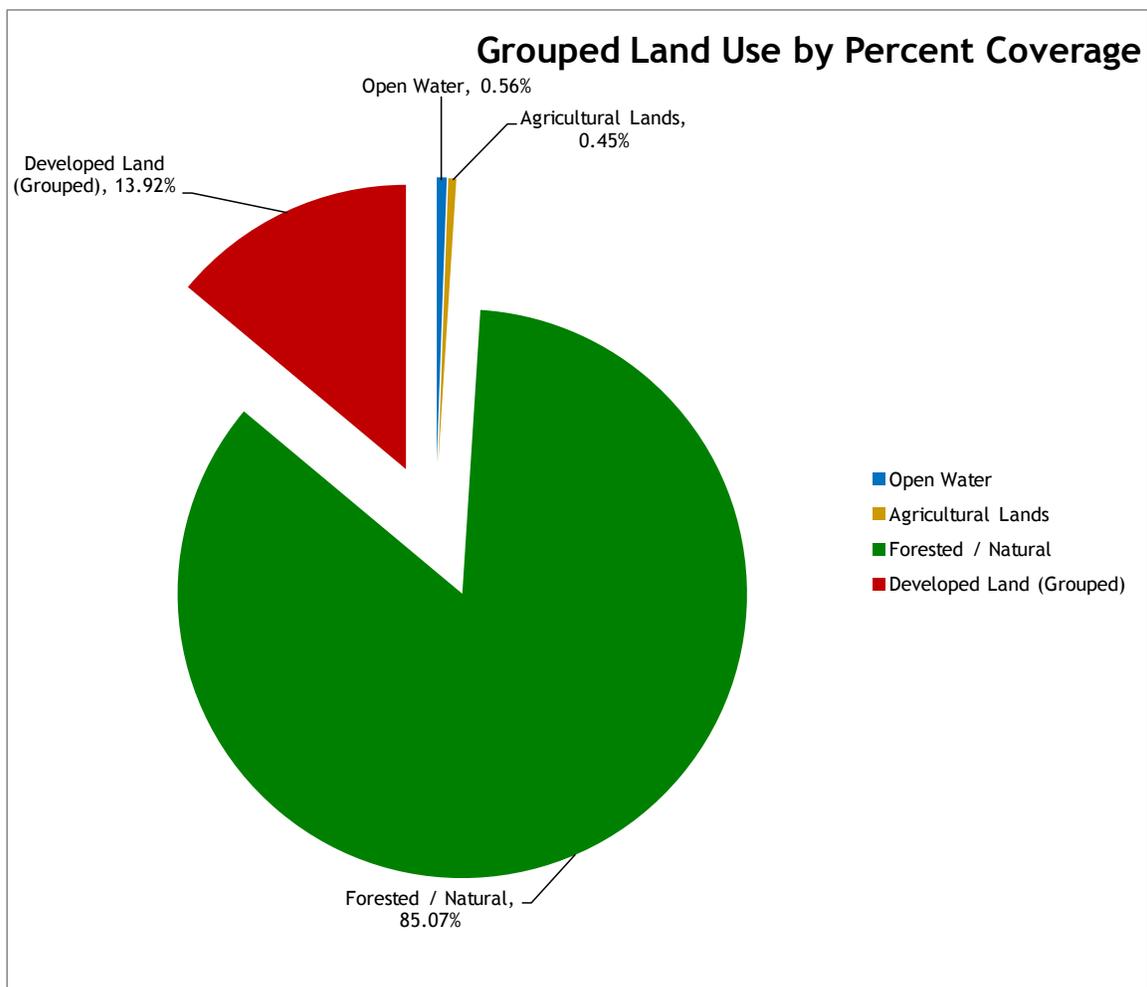


Table 3-2. Land Use Areas for the Daniel Creek Watershed

Class Description	Count (30m)	Mi²	Acres	Percent
Open Water	293	0.10	65.07	0.56%
Agricultural Lands	234	0.08	52.10	0.45%
Forested / Natural	44243	15.37.22	9839.37	85.07%
Developed Land (Grouped)	7237	2.51	1609.49	13.92%
TOTALS →	52007	18.07	11566.03	100.00%

Figure 3-3. Land Uses Graph of the Daniel Creek Watershed



3.4 Data Availability and Analysis

It should be noted that even though Daniel Creek was sampled prior to 2007, only the data that is approximately six years in age or less will be used in this analysis which is consistent with Alabama's Water Quality Assessment and Listing Methodology (ADEM, 2012).

The source of data that was utilized in the evaluation of Daniel Creek is from ADEM's 2007 and 2012 303(d) sampling program. Both physical and chemical data was collected at the following sampling station: DNC-1, which can be found in Appendix 6.2, page 15. Refer to Table 3.4 for location description of the aforementioned sampling station and to Figure 3.4 for a map depicting the location of the sampling station.

ADEM collected 11 chromium samples at DNC-1 during the 2012 and 2007 sampling events. Of the 11 samples collected there were no chromium violations reported. Based on review of the data, ADEM has determined that no violations of chromium are present. Please refer to Table 3.5 and Table 3.6 for a summary of the chromium (Cr) results.

ADEM collected 11 lead samples at DNC-1 during the 2012 and 2007 sampling events. Of the 11 samples collected there were no lead violations reported. Based on review of the data, ADEM has determined that no violations of lead are present. Please refer to Table 3.5 and Table 3.6 for a summary of the Lead (Pb) results.

Table 3.3 Summary of Metals Analysis for Daniel Creek

				Hardness dependent					
Station_ID	Date	Hardness (mg/l)	TSS (mg/l)	Cd-dis (mg/l)	Cr-dis (mg/l)	Cu-dis (mg/l)	Pb-dis (mg/l)	Ni-dis (mg/l)	Zn-dis (mg/l)
EPA Analytical Method				200.7	200.7	200.7	239.2	200.7	200.7
Method Detection Limit (MDL)				0.0030	0.0150	0.0200	0.0020	0.0300	0.0300
Criteria @ sampled hardness				0.0006	0.2039	0.0257	0.0094	0.1479	0.3365
DNC-1	3/27/2007	344*	17	0.00007	LDL/0.002	0.0020	LDL/0.0011	0.0100	LDL/0.002
Criteria @ sampled hardness				0.0006	0.2174	0.0275	0.0102	0.1580	0.3596
DNC-1	5/30/2007	372	4	LDL/0.0002	LDL/0.01	LDL/0.01	LDL/0.005	LDL/0.01	LDL/0.01
Criteria @ sampled hardness				0.0004	0.1445	0.0180	0.0060	0.1037	0.2357
DNC-1	6/27/2007	226	4	LDL/0.005	LDL/0.004	LDL/0.005	LDL/0.00147	LDL/0.006	LDL/0.006
Criteria @ sampled hardness				0.0006	0.1985	0.0250	0.0091	0.1439	0.3274
DNC-1	7/19/2007	333	4	LDL/0.005	LDL/0.004	LDL/0.005	LDL/0.00147	LDL/0.006	LDL/0.006
Criteria @ sampled hardness				0.0005	0.1600	0.0200	0.0069	0.1152	0.2620
DNC-1	8/22/2007	256	2	LDL/0.005	LDL/0.004	LDL/0.005	LDL/0.00147	LDL/0.006	LDL/0.006
Criteria @ sampled hardness				0.0007	0.2461	0.0313	0.0119	0.1797	0.4090
DNC-1	9/26/2007	433	4	LDL/0.005	LDL/0.004	0.01	LDL/0.00147	LDL/0.006	LDL/0.006
Criteria @ sampled hardness				0.0007	0.2508	0.0319	0.0121	0.1832	0.4170
DNC-1	10/30/2007	443	1 <MDL	LDL/0.009	LDL/0.01	LDL/0.002	0.0040	LDL/0.024	0.0140
Criteria @ sampled hardness				0.0006	0.2034	0.0257	0.0093	0.1475	0.3357
DNC-1	11/27/2007	343	1	LDL/0.005	LDL/0.004	0.0090	LDL/0.00147	LDL/0.006	LDL/0.006
Criteria @ sampled hardness				0.0004	0.1456	0.0181	0.0061	0.1044	0.2375
DNC-1	5/9/2012	228	25	LDL/0.000009	LDL/0.005	LDL/0.3	LDL/0.0016	LDL/0.01	LDL/0.02
Criteria @ sampled hardness				0.0007	0.2480	0.0316	0.0120	0.1811	0.4122
DNC-1	7/5/2012	437	2	LDL/0.000009	LDL/0.005	LDL/0.3	LDL/0.0016	LDL/0.01	LDL/0.02
Criteria @ sampled hardness				0.0007	0.2447	0.0311	0.0118	0.1786	0.4066
DNC-1	9/12/2012	430	4	LDL/0.000009	LDL/0.005	LDL/0.1	LDL/0.0016	LDL/0.01	LDL/0.02
Notes:									
(*) no sample collected - mean of 2007 values used									
shaded cells denote method detection limit is greater than the metal criterion									

Table 3.4 Daniel Creek Sampling Stations

ADEM Station	Latitude	Longitude	Description
DNC-1	33.29500	-87.36440	Camp Cherry Austin Rd

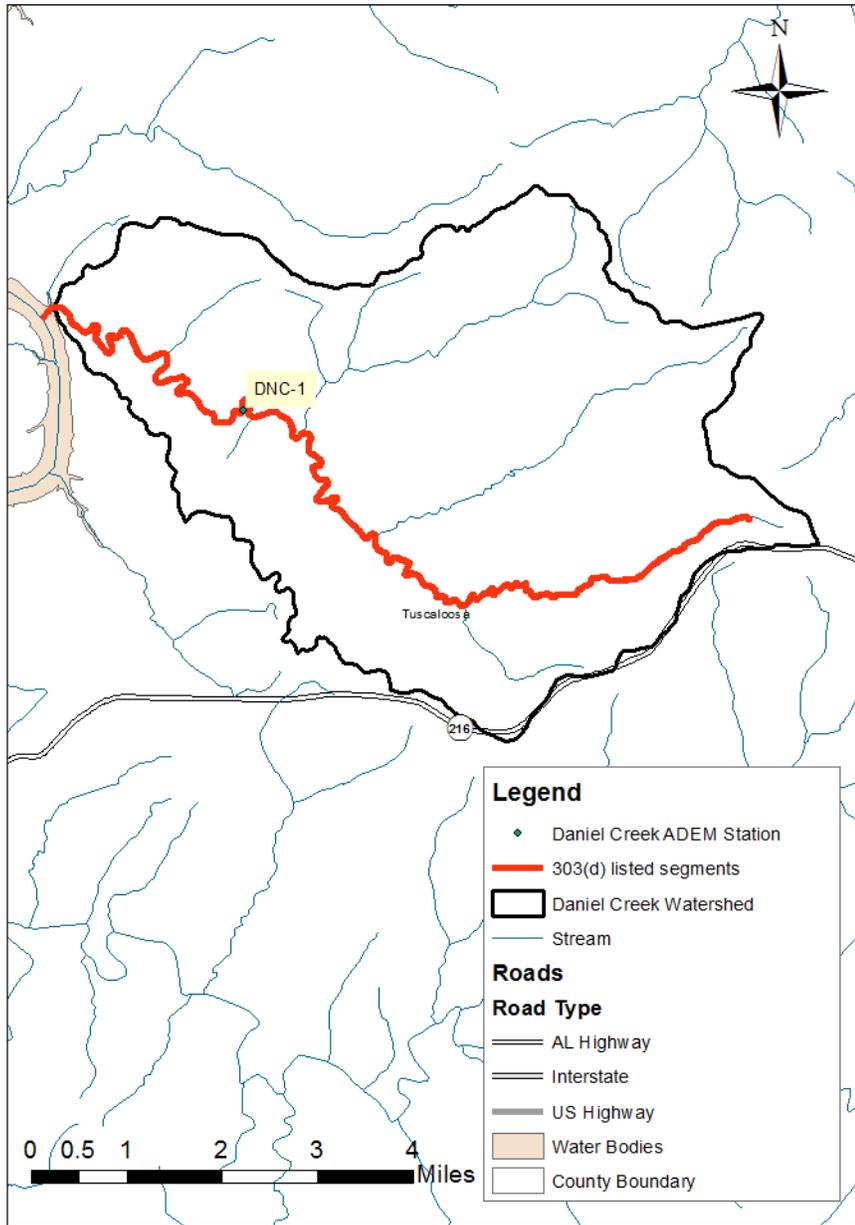
Table 3.5 Summary of 2012 Daniel Creek Metals (Cr, Pb) Results

Station	Metal	Total # of Samples Collected	Total # of Violations	% of Violations	Support Status
DNC-1	Cr	3	0	0	Full
DNC-1	Pb	3	0	0	Full

Table 3.6 Summary of 2007 Daniel Creek Metals (Cr, Pb) Results

Station	Metal	Total # of Samples Collected	Total # of Violations	% of Violations	Support Status
DNC-1	Cr	8	0	0	Full
DNC-1	Pb	8	0	0	Full

Figure 3.4 - Map of Sampling Locations for Daniel Creek



4.0 Conclusions

From examination of all available data, ADEM has determined that a water quality impairment due to Metals (Cr, Pb) does not currently exist within Daniel Creek. Therefore, ADEM will not develop a TMDL due to “more recent data” which is a just cause for delisting waterbodies according to Title 40 of the Code of Federal Regulations (CFR), Part 130.7(b)(6)(iv).

5.0 Public Participation

As part of the public participation process, this Delisting Decision (DD) will be placed on public notice and made available for review and comment. A public notice will be prepared and published in the major daily newspapers in Montgomery, Huntsville, Birmingham, and Mobile, as well as submitted to persons who have requested to be on ADEM's postal and electronic mailing distributions. In addition, the public notice and subject DD will be made available on ADEM's Website: www.adem.state.al.us. The public can also request hard or electronic copies of the DD by contacting Mr. Chris Johnson at 334-271-7827 or clj@adem.state.al.us. The public will be given an opportunity to review the DD and submit comments to the Department in writing. At the end of the comment period, all written comments received during the public notice period will become part of the administrative record. ADEM will consider all comments received by the public prior to final completion of this DD and subsequent submission to EPA Region 4 for final approval.

Appendix 6.1

References

ADEM Administrative Code, 2002. Water Quality Program, Chapter 335-6-10, Water Quality Criteria, and Chapter 335-6-11 Use Classifications for Interstate and Intrastate Waters.

Alabama Department of Environmental Management's 303(d) Monitoring Program. 2007 and 2012.

Alabama Department of Environmental Management (ADEM). Alabama's Water Quality Assessment and Listing Methodology, January 2012.

United States Environmental Protection Agency. 1991. Guidance for Water Quality-Based Decisions: The TMDL Process, Office of Water, EPA 440/4-91-001.

Alabama Department of Environmental Management (ADEM). Alabama's 1998 Water Quality Report to Congress. 1998.

United States Environmental Protection Agency. Surface Water Quality Screening Assessment of the Black Warrior River Basin. January 1999.

Appendix 6.2 Water Quality Data

**Data from 2007, 2012 303(d) Monthly Sampling Metals
Station DNC-1**

Station ID	Visit Date	TSS mgL	TSS dc	TDS mgL	Hard mgL	Turb NTU	Turb dc	Ag Dis mgL	Ag Dis dc	Al Tot mgL	Al Tot dc	As Dis µg/L	As Dis dc	Cd Dis mgL	Cd Dis dc
DNC-1	3/27/2007	17		716		1.78	NTU	6E-05	RI	0.14		0.5	< MDL .5	7E-05	RI
DNC-1	5/30/2007	4		824	372	1.23	NTU	0.0005	< MDL .0005	0.11		5	< MDL 5	0.0002	< MDL .0002
DNC-1	6/27/2007	4		830	226	1.08	NTU	0.003	< MDL .003	0.15	< MDL .15			0.005	< MDL .005
DNC-1	7/19/2007	4		15	333	2.22	NTU	0.003	< MDL .003	0.017				0.005	< MDL .005
DNC-1	8/22/2007	2		488	256	2.07	NTU	0.003	< MDL .003	0.022	JI	2.2	< MDL 2.2	0.005	< MDL .005
DNC-1	9/26/2007	4		897	433	1.92	NTU	0.003	< MDL .003	0.015	< MDL .015	2.2	< MDL 2.2	0.005	< MDL .005
DNC-1	10/30/2007	1	< MDL 1	1216	443	1.23	NTU	0.0017		0.2	< MDL .2	5	< MDL 5	0.009	< MDL .009
DNC-1	11/27/2007	1		960	343	2.82	NTU	0.003	< MDL .003	0.015	< MDL .015			0.005	< MDL .005
DNC-1	5/9/2012	23		475	228	33.2	NTU	0.001	< MDL .001, JQ2	0.462		1	< MDL 1	9E-05	< MDL .09
DNC-1	7/5/2012	2		889	437			0.001	< MDL .001	0.03	< MDL .03	1	< MDL 1	9E-05	< MDL .09, JQ1
DNC-1	9/12/2012	4		712	430	1.52	NTU	0.001	< MDL .001	0.232		1	< MDL 1	9E-05	< MDL .09

Station ID	Visit Date	Al Dis mgL	Al Dis dc	Fe Dis mgL	Fe Dis dc	Fe Tot mgL	Fe Tot dc	Mn Dis mgL	Mn Dis dc	Mn Tot mgL	Mn Tot dc	Sb Dis µg/L	Sb Dis dc	Cr Dis mgL	Cr Dis dc
DNC-1	3/27/2007	0.12		0.01	< MDL .01	0.12		0.68		0.72		1.6	< MDL 1.6	0.002	
DNC-1	5/30/2007	0.22		0.06	< MDL .06	0.1		0.38		0.37		5	< MDL 5	0.01	< MDL .01
DNC-1	6/27/2007	0.015	< MDL .015	0.005	< MDL .005	0.098		0.106	JI	0.144		1.97	< MDL 1.97	0.004	< MDL .004
DNC-1	7/19/2007	0.015	< MDL .015	0.005	< MDL .005	0.1		0.741		0.751		1.97	< MDL 1.97	0.004	< MDL .004
DNC-1	8/22/2007	0.015	< MDL .015	0.005	< MDL .005	0.197	JI	0.092	JI	0.123	JI	1.97	< MDL 1.97	0.004	< MDL .004
DNC-1	9/26/2007	0.015	< MDL .015	0.005	< MDL .005	0.102	JI	0.241	JI	0.244	JI	1.97	< MDL 1.97	0.004	< MDL .004
DNC-1	10/30/2007	0.2	< MDL .2	0.05	< MDL .05	0.22		1.05		1.3		6	JQ2	0.01	< MDL .01
DNC-1	11/27/2007	0.015	< MDL .015	0.015	JI	0.205	JI	0.661	JI	0.722	JI	1.97	< MDL 1.97	0.004	< MDL .004
DNC-1	5/9/2012	0.079	JI	0.1	< MDL .1	1.27		1.87		1.67		2.58	JI	0.005	< MDL .005
DNC-1	7/5/2012	0.03	< MDL .03, JQ1	0.1	< MDL .1	0.19		0.342		0.343		0.8	< MDL .8	0.005	< MDL .005
DNC-1	9/12/2012	0.03	< MDL .03	0.1	< MDL .1	1.76		0.712		1.17		0.999	JI	0.005	< MDL .005

**Data from 2007, 2012 303(d) Monthly Sampling Metals
Station DNC-1 (Continued)**

Station ID	Visit Date	Cu Dis mg/L	Cu Dis dc	Pb Dis µg/L	Pb Dis dc	Hg Dis µg/L	Hg Dis dc	Ni Dis mg/L	Ni Dis dc	Se Dis µg/L	Se Dis dc	Tl Dis µg/L	Tl Dis dc	Zn Dis mg/L	Zn Dis dc
DNC-1	3/27/2007	0.002		1.1	< MDL 1.1	0.5	< MDL .5, JH	0.01		1.6	< MDL 1.6	1.2	< MDL 1.2	0.002	< MDL .002
DNC-1	5/30/2007	0.01	< MDL .01	5	< MDL 5	0.5	< MDL .5	0.01	< MDL .01	5	< MDL 5	2.5	< MDL 2.5	0.01	< MDL .01
DNC-1	6/27/2007	0.005	< MDL .005	1.47	< MDL 1.47	0.3	< MDL .3	0.006	< MDL .006	1.62	< MDL 1.62	0.61	< MDL .61	0.006	< MDL .006
DNC-1	7/19/2007	0.005	< MDL .005	1.47	< MDL 1.47	0.3	< MDL .3	0.006	< MDL .006	1.62	< MDL 1.62	0.61	< MDL .61	0.006	< MDL .006
DNC-1	8/22/2007	0.005	< MDL .005	1.47	< MDL 1.47	0.087	J1	0.006	< MDL .006	1.62	< MDL 1.62	0.61	< MDL .61	0.006	< MDL .006
DNC-1	9/26/2007	0.01	J1	1.47	< MDL 1.47	0.03	< MDL .03	0.006	< MDL .006	1.62	< MDL 1.62	0.61	< MDL .61	0.006	< MDL .006
DNC-1	10/30/2007	0.002	< MDL .002	4	JQ2	0.03	< MDL .03	0.024	< MDL .024	5	< MDL 5	9	< MDL 9	0.014	
DNC-1	11/27/2007	0.009	J1	1.47	< MDL 1.47	0.03	< MDL .03	0.006	< MDL .006	1.62	< MDL 1.62	0.61	< MDL .61	0.006	< MDL .006
DNC-1	5/9/2012	0.3	< MDL .3	1.6	< MDL 1.6			0.01	< MDL .01	2	< MDL 2	0.432	< MDL .432	0.02	< MDL .02
DNC-1	7/5/2012	0.3	< MDL .3	1.6	< MDL 1.6			0.01	< MDL .01	2	< MDL 2	0.432	< MDL .432	0.02	< MDL .02, JQ1
DNC-1	9/12/2012	0.1	< MDL .1	1.6	< MDL 1.6			0.01	< MDL .01	2	< MDL 2	0.432	< MDL .432	0.02	< MDL .02

**Data from 1999 Monthly Sampling Metals
Station DNC-1**

Station ID	Visit Date	Hardness mgl	Cd Tot mgl	Cd Tot dc	Cr Tot mgl	Cr Tot dc	Cu Tot mgl	Cu Tot dc	Zn Tot mgl	Zn Tot dc	Pb Tot ug/l	Pb Tot dc
DNC-1	5/12/1999		0.003	< MDL .003	0.015	< MDL .015						
DNC-1	7/28/1999		0.003	< MDL .003	0.015	< MDL .015						
DNC-1	8/10/1999		0.003	< MDL .003	0.015	< MDL .015						
DNC-1	9/21/1999		0.003	< MDL .003	0.057							

Appendix 6.3

Equations for calculating specific metals criteria

1. Cadmium

(i) freshwater acute aquatic life:

$$\text{conc. } (\mu\text{g/l}) = e^{(1.0166[\ln(\text{hardness in mg/l as CaCO}_3)]-3.924)} \text{ (CF) (Eq. 1)}$$

$$\text{conversion factor (CF) = } 1.136672 - [\ln(\text{hardness})(0.041838)]$$

(ii) freshwater chronic aquatic life:

$$\text{conc. } (\mu\text{g/l}) = e^{(0.7409[\ln(\text{hardness in mg/l as CaCO}_3)]-4.719)} \text{ (CF) (Eq. 2)}$$

$$\text{conversion factor (CF) = } 1.101672 - [\ln(\text{hardness})(0.041838)]$$

2. Chromium (trivalent)

(i) freshwater acute aquatic life:

$$\text{conc. } (\mu\text{g/l}) = e^{(0.8190[\ln(\text{hardness in mg/l as CaCO}_3)]+3.7256)} \text{ (CF) (Eq. 3)}$$

$$\text{conversion factor (CF) = } 0.316$$

(ii) freshwater chronic aquatic life:

$$\text{conc. } (\mu\text{g/l}) = e^{(0.8190[\ln(\text{hardness in mg/l as CaCO}_3)]+0.6848)} \text{ (CF) (Eq. 4)}$$

$$\text{conversion factor (CF) = } 0.860$$

3. Copper

(i) freshwater acute aquatic life:

$$\text{conc. } (\mu\text{g/l}) = e^{(0.9422[\ln(\text{hardness in mg/l as CaCO}_3)]-1.700)} \text{ (CF) (Eq. 5)}$$

$$\text{conversion factor (CF) = } 0.960$$

(ii) freshwater chronic aquatic life:

$$\text{conc. } (\mu\text{g/l}) = e^{(0.8545[\ln(\text{hardness in mg/l as CaCO}_3)]-1.702)} \text{ (CF) (Eq. 6)}$$

$$\text{conversion factor (CF) = } 0.960$$

4. Lead

(i) freshwater acute aquatic life:

$$\text{conc. } (\mu\text{g/l}) = e^{(1.273[\ln(\text{hardness in mg/l as CaCO}_3)]-1.460)} \text{ (CF) (Eq. 7)}$$

$$\text{conversion factor (CF) = } 1.46203 - [\ln(\text{hardness})(0.145712)]$$

(ii) freshwater chronic aquatic life:

$$\text{conc. } (\mu\text{g/l}) = e^{(1.273[\ln(\text{hardness in mg/l as CaCO}_3)]-4.705)} \text{ (CF) (Eq. 8)}$$

$$\text{conversion factor (CF) = } 1.46203 - [\ln(\text{hardness})(0.145712)]$$

5. Nickel

(i) freshwater acute aquatic life:

$$\text{conc. } (\mu\text{g/l}) = e^{(0.8460[\ln(\text{hardness in mg/l as CaCO}_3)]+2.255)} \text{ (CF) (Eq. 9)}$$

$$\text{conversion factor (CF) = } 0.998$$

(ii) freshwater chronic aquatic life:

$$\text{conc. } (\mu\text{g/l}) = e^{(0.8460[\ln(\text{hardness in mg/l as CaCO}_3)]+0.0584)} \text{ (CF) (Eq. 10)}$$

$$\text{conversion factor (CF) = } 0.997$$

6. Pentachlorophenol

(i) freshwater acute aquatic life:

$$\text{conc. } (\mu\text{g/l}) = e^{[1.005(\text{pH})-4.869]} \text{ (Eq. 11)}$$

(ii) freshwater chronic aquatic life:

$$\text{conc. } (\mu\text{g/l}) = e^{[1.005(\text{pH})-5.134]} \text{ (Eq. 12)}$$

7. Silver

(i) freshwater acute aquatic life:

$$\text{conc. } (\mu\text{g/l}) = e^{(1.72[\ln(\text{hardness in mg/l as CaCO}_3)]-6.52)} \text{ (CF) (Eq. 13)}$$

$$\text{conversion factor (CF) = } 0.85$$

8. Zinc

(i) freshwater acute aquatic life:

$$\text{conc. } (\mu\text{g/l}) = e^{(0.8473[\ln(\text{hardness in mg/l as CaCO}_3)]+0.884)} (\text{CF}) \quad \text{(Eq. 14)}$$

$$\text{conversion factor (CF)} = 0.978$$

(ii) freshwater chronic aquatic life:

$$\text{conc. } (\mu\text{g/l}) = e^{(0.8473[\ln(\text{hardness in mg/l as CaCO}_3)]+0.884)} (\text{CF}) \quad \text{(Eq. 15)}$$

$$\text{conversion factor (CF)} = 0.986$$

(i) Consumption of water and fish:

$$\text{conc. (mg/l)} = (\text{HBW} \times \text{RfD} \times \text{RSC}) / [(\text{FCR} \times \text{BCF}) + \text{WCR}] \quad \text{(Eq. 16)}$$

(ii) Consumption of fish only:

$$\text{conc. (mg/l)} = (\text{HBW} \times \text{RfD} \times \text{RSC}) / (\text{FCR} \times \text{BCF}) \quad \text{(Eq. 17)}$$

where: HBW = human body weight, set at 70 kg

RfD = reference dose, in mg/(kg-day)

FCR = fish consumption rate, set at 0.030 kg/day

BCF = bioconcentration factor, in l/kg

WCR = water consumption rate, set at 2 l/day

Appendix 6.4 Daniel Creek Watershed Photos

Photo 7-1 Daniel Creek at DNC-1 August 14, 2012 Looking Upstream



Photo 7-2 Daniel Creek at DNC-1 August 14, 2012 Looking Downstream



Photo 7-1 Daniel Creek at DNC-1 September 12, 2012 Looking Upstream



Photo 7-2 Daniel Creek at DNC-1 September 14, 2012 Looking Downstream

